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Proceedings of the regional peer review of the assessment of Dolly Varden from the Babbage River, Yukon Territory

February 9–10, 2015
Winnipeg, Manitoba

Chairperson: Margaret Treble
Editor: Heather Clark and Colin Gallagher

Fisheries and Oceans Canada
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Winnipeg, Manitoba, R3T 2N6

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Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings may include research recommendations, uncertainties, and the rationale for decisions made during the meeting. Proceedings may also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

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SUMMARY

A Regional Advisory Process was held at the Freshwater Institute in Winnipeg to assess anadromous Dolly Varden (*Salvelinus malma*) from the Babbage River, Yukon Territory. The meeting was held on February 9–10, 2015 and included participants from Fisheries and Oceans Canada, Fisheries Joint Management Committee, Gwich'in Renewable Resources Board, University of Manitoba, British Columbia Ministry of Environment, Parks Canada, and harvesters from Aklavik and Fort McPherson. During the meeting, presentations were made on various topics relevant to the assessment including background information, counts of fish using DIDSON sonar, multiple mark-recapture population estimates, biological information collected during mark-recapture, genetic population structure and effective population size, genetic mixed-stock fishery analysis, and reported coastal harvest. The meeting objectives were met and advice was provided to co-management partners, most importantly that the population was stable and the current level of harvest was sustainable. Publications from the meeting included a Science Advisory Report and Research Documents.

Compte rendu de l'examen régional par les pairs sur l'évaluation du Dolly Varden de la rivière Babbage, au Territoire du Yukon

SOMMAIRE

Un processus de consultation régional s'est déroulé à l'Institut des eaux douces, à Winnipeg, afin d'évaluer le Dolly Varden (*Salvelinus malma*) de la rivière Babbage, au Territoire du Yukon. La réunion s'est tenue les 9 et 10 février 2015, avec la participation de représentants de Pêches et Océans Canada, du Comité mixte de gestion des pêches, du Conseil des ressources renouvelables Gwich'in, de l'Université du Manitoba, du ministère de l'Environnement de la Colombie-Britannique et de Parcs Canada, ainsi que de pêcheurs venus d'Aklavik et de Fort McPherson. Durant la réunion, des exposés ont été présentés et abordaient divers sujets pertinents à l'évaluation, notamment les renseignements généraux, le dénombrement de poissons par sonar DIDSON, les estimations de populations au moyen d'une méthode de marquage et de recapture, les renseignements biologiques recueillis lors du marquage et de la recapture, la structure génétique de la population et l'effectif réel de la population, l'analyse génétique de stocks mélangés, et la pêche côtière déclarée. Les objectifs de la réunion ont été atteints et les partenaires de cogestion ont reçu des conseils leur indiquant avant tout que la population est stable et que le niveau actuel de pêche est durable. Les publications issues de la réunion comprennent un avis scientifique et des documents de recherche.

INTRODUCTION

The purpose of the peer-review was to assess the status of anadromous Dolly Varden from the Babbage River, Yukon Territory. Data from multiple sources (e.g., mark-recapture, genetics, and reported harvest) were reviewed in order to evaluate trends in population abundance, demographic properties, contribution to coastal fisheries, and harvest rate. The meeting began with a review of the meeting terms of reference (Appendix 1), introductions of participants (Appendix 2) and review of the agenda (Appendix 3).

PRESENTATIONS AND DETAILED DISCUSSION

PRESENTATION 1: BACKGROUND

Presenter: Colin Gallagher

An overview was provided of the geography of the Babbage River and the life histories, key habitats and seasonal migration patterns of Dolly Varden from the Babbage River stock. Maps illustrating locations along the Beaufort Sea coast where Dolly Varden are harvested were shown. Finally, past research conducted on the Babbage River stock was summarized.

DISCUSSION

During the discussion it was clarified that samples were collected in 1986 and 1988 from North Slope river systems in order to determine species distribution and resolve char taxonomic issues in the western Arctic (Dolly Varden or Arctic Char). It was noted that there were two confirmed populations of Arctic Char west of the mainstem of the Firth River in Ivvavik National Park (Lake 103 and Lake 104). The samples collected in the late 1980s were also used to examine population structure and life history types among rivers.

PRESENTATION 2: DIDSON

Presenter: Colin Gallagher

Data from a Dual Frequency Identification Sonar (DIDSON) deployed in the mainstem of the Babbage River between July 22 and September 11, 2011 were used to enumerate and measure fish as they moved in an upstream direction. The data collected with the sonar were used to estimate the number of migrating fish (Dolly Varden and Arctic Grayling cannot be visually differentiated), evaluate migration timing, and estimate the length of individual fish. Using data from a weir study conducted during the upstream migration of Dolly Varden in 1992 it was possible to estimate the proportion of Arctic Grayling encountered (32% of total count) and use this as a correction factor for the DIDSON counts. Counts of fish ≥250 mm (approximate size-at-smoltification) and ≤420 mm fork length (size range where Dolly Varden and Arctic Grayling in the Babbage River overlap) ranged between 4,050 and 5,030. In order to compare more directly with results from the mark-recapture studies the number of Dolly Varden ≥365 mm and ≤420 mm was estimated and found to range between 2,839 and 3,119 (including correction factor); these values were considerably lower than the population estimates from mark-recapture studies (see results below). The DIDSON data demonstrated that fish make diel upstream movements. The timing of fish passage was slightly earlier compared to weir studies conducted in the early 1990s. Size structure was similar to the weir data, with a range of approximately 250–650 mm and contributions from juveniles in both sampling periods, although the proportion of fish >450 mm in length were lower in the DIDSON.

DISCUSSION

There was discussion about the choice of correction factor. The working paper presented results from a weir study conducted in 1990 and 1992 where Arctic Grayling accounted for 50% and 32% of the total catch, respectively. The correction factor of 32% was chosen for the presentation because it was the most recent. One person suggested using an average of both values. Another participant mentioned taking the values from the year that coincided best with the dates the DIDSON was recording as this may better account for possible seasonal effects of grayling abundance/ movements. Someone else recommended acknowledging the uncertainty and to determine a range using a number of randomizations rather than gravitating towards a fixed number. Another suggestion was to determine if there were any behavioural studies that demonstrated whether grayling conduct concentrated upstream migrations in the fall in systems similar to the Babbage River. Someone stated that in the Vittrekwa River there was movement of large grayling in early September in a tributary used by spawning char and that there may be evidence of migratory movements in the Blackstone River. It was suggested to examine the DIDSON data to determine if there were pulses of grayling-size fish in late August or early September. It was mentioned that published reports of local knowledge stating that overwintering char have been caught in the lower reach of the Babbage River complicates the use of counts from the DIDSON in 2011. A question was asked whether the proportion of Arctic Grayling captured during seining at the spawning/ overwintering area in the fall could be used to estimate a correction factor for the DIDSON. The reply was that the seining occurred at a different place and time than the DIDSON, so there was hesitation to use these data. However if no other data were available then it would be an option. It was also noted by the presenter that hoop netting concurrent with the deployment of the DIDSON caught few fish and that there would be low confidence in using these data to generate a correction factor. One participant stated that it may be possible to use counts of fish ≥420 mm in length (exclusively Dolly Varden) as an index of abundance if future DIDSON projects are conducted on the Babbage River.

PRESENTATION 3: MARK-RECAPTURE POPULATION ESTIMATES

Presenter: Colin Gallagher

The results of a multi-year mark-recapture study conducted at the end of September at the spawning/ overwintering area of the Babbage River stock between 2010 and 2014 were presented. The methodology was described including capture method (seining), locations where fish were captured, application of tags (t-bar at the base of the dorsal fin of Dolly Varden ≥300 mm in length), recording instances of recaptures, and the collection of biological information (length, sex/ reproductive condition). The Petersen model was utilized to estimate abundance based on the application of tags to Dolly Varden in one year and recapture by sampling in the same general vicinity and month in the following year. Assumptions of the Petersen model were reviewed and the methods used to adjust the data when assumptions were not fully met were described. Population estimates generated for 2010, 2011, and 2012, ranged between 5,861 (95% CI = 3,967– 5,861) and 6,553 (95% CI = 4,005–6,553). The 2013 estimate was much higher (10,356 (95% CI = 6,685–20,329)), however, the accuracy of the estimate is uncertain due to the high proportion of smaller-sized fish tagged in 2013 that were likely not as vulnerable to recapture the following year which would violate an assumption of the Petersen model and inflate the estimate of abundance. Abundance estimates based on a mark-recapture study between 1990 and 1992 using a weir deployed during upstream migration were higher compared to estimates from recent years. An interpretation of a decline in abundance should be treated cautiously due to the differences in methodology used between both time periods.

DISCUSSION

A person who asked why smaller fish were not tagged was told that 300 mm was an arbitrary length chosen based on the perception that smaller fish could be affected by a dorsal tag. The choice of model was questioned with the participant noting that an open population model such as Jolly-Seber would allow for the use of all the tagging data without as many constraints in meeting a number of assumptions and would also provide additional data such as mortality estimates. The presenter replied that the Petersen model was used to maintain consistency with what had been done in the past in other populations of Dolly Varden and that alternative models would be evaluated in the future using programs such as MARK. Someone suggested that it would also be worthwhile to build models in the statistical program R.

One of the assumptions of the Petersen model is that the population is closed. There was a fish tagged in the Babbage in 2011 that was recaptured in Joe Creek in 2014 so the closed population assumption may not be met for the Babbage River and the meeting discussed the implications of this for the model. It was confirmed by participants with expertise in Dolly Varden genetics that gene dispersal is low among river systems and one or two fish that stray between systems would have a minimal impact on the model assumption. However, there was gene flow observed between the Firth and Babbage suggesting at least these two rivers are not closed.

Discussion was held regarding the assumption that all tagged fish were equally catchable, given that not as many small fish (<425 mm) as expected were recaptured in 2013. A participant asked if there was a difference in mortality rate resulting from applying tags to small versus large fish. The reply was that a bigger issue would be a differential rate of tag loss. One participant suggested that smaller fish could be more vulnerable to predation and also made the point that smaller fish may be more mobile on the spawning/ overwintering grounds and less vulnerable to the seine net compared to spawners who presumably remain in the immediate area defending territory. Someone mentioned that there may be higher fishing mortality for smaller fish along the coast because harvesters use small mesh gillnets that are not as efficient in catching large-sized individuals.

One participant suggested that a double-tagging experiment would be a good idea as the rate of tag-loss may vary among river systems. Another suggested increasing the geographic coverage at the spawning/ overwintering area for mark-recapture studies and also recommended using non-selective alternative gear (e.g., electrofishing) to supplement the seining in order to obtain recaptures, thereby removing sampling biases.

PRESENTATION 4: POPULATION DEMOGRAPHICS

Presenter: Colin Gallagher

The results of the biological data collected while seining for the mark-recapture study between 2010 and 2014, and from seining conducted in 1987 at the same location and time of the year were provided. The data included: length structure (length frequency and boxplots) among reproductive stages (non-spawner, and female and male spawner); the proportion of each reproductive stage in the total catch; growth between sexes based on tag returns (note, in the working paper this included a small number of Babbage tag returns recaptured in the summer fishery at Shingle Point); growth between 1990–1992 and 2010–2014 based on tag returns; estimated size-at-maturity, and prevalence of repeat and skip spawning. The results demonstrated stable size distributions/ median values among years without considerable change since 1987. The proportion of non-spawners, female spawners and male spawners were similar among all years. Males had a higher rate of growth compared to females and growth in 2010–2014 was higher compared to the early 1990s. The majority of females and

males were mature by 450 and 575 mm, respectively. The prevalence of repeat spawning was considerably higher in females compared to males.

DISCUSSION

A suggestion was made to remove the small number of fish recaptured in the summer coastal fishery at Shingle Point as they did not live a full year since being tagged. The presenter agreed that it would be appropriate to remove fish recaptured from Shingle Point. It was also noted the growth data could be interpreted as an annual growth rate as fish were typically recaptured one year later (in some cases to the exact day). A participant asked if the broad pattern observed in growth in the total sample of recaptures for 2010–2014 could be a result of variable inter-annual conditions in the Beaufort Sea. The response was that the variability was likely highly influence by annual changes in life history (e.g., non-spawner to spawner and consecutive- or alternate-year spawning). Someone identified an error in the methodology used in the parameterization to estimate length-at-50%-maturity and suggested a simple solution to rectify the problem.

PRESENTATION 5: GENETIC POPULATION STRUCTURE AND EFFECTIVE POPULATION SIZE

Presenter: Les Harris

Population structure and estimate of effective population size (N_e) of Dolly Varden from the North Slope were examined using genetic techniques. Results provided insight into the demographic independence of populations, factors driving genetic variation and structure, and the viability and evolutionary potential of populations. Microsatellite analysis across 17 loci was applied to 1,436 samples collected from 10 locations and three life history types. Genetic variation conformed to expectations based on degree of isolation and potential for gene flow. The results indicated highly structured populations among the anadromous samples and no genetic structure between resident and anadromous forms from the same system. Samples of fish collected above impassable barriers (i.e., 'isolated' life history form) were highly divergent from anadromous/ resident forms from the same system. The data also suggested that population structure was temporally stable. Based on gene flow estimates, straying of anadromous Dolly Varden between the Babbage River and Joe Creek/ Firth River stocks was approximately 3.8% and biased towards non-spawning males. The N_e results of four anadromous stocks were calculated with the data from the Babbage River N_e = was 627 (-95% CI = 146; note that +95% CI could not be calculated when combining means within methods due to some results of infinity) suggesting no immediate conservation concerns with respect to inbreeding and reduced fitness.

DISCUSSION

One participant required clarification of the 3.8% straying between Babbage River and Firth River/Joe Creek. It was stated a straying rate of 0.0004% may be enough to homogenize genetic differences between theoretical populations. Given that most of the straying is occurring with non-spawners, this reduces the potential for gene flow and the homogenization of genetic variation associated with it. The concept of N_e was clarified (the number of individuals needed to recreate the genetic composition/ characteristics of a given population) and that N_e is always less than N_c (population size) where $N_e < 50$ is a concern and $N_e < 500$ is not of major concern (although the population may be vulnerable to disturbances).

PRESENTATION 6: GENETIC MIXED-STOCK FISHERY ANALYSIS

Presenter: Rob Bajno

Methods and results of a genetic mixed-stock fishery analysis using samples of Dolly Varden collected along the Canadian Beaufort Sea coast between 2011 and 2014 were described. Published information relevant to genetic studies of Dolly Varden was reviewed. Microsatellite analysis (15 loci) was used to develop a genetic baseline of known stocks (n= 8), including samples from stocks in Alaska (note, the multiple Alaskan stocks were combined into three reporting groups). Statistical analyses were conducted to estimate the population of origin for individual samples and stock mixture analysis was done using both conditional maximum likelihood and Bayesian methods. Estimated stock contributions with 95% confidence intervals were presented for individual harvesting locations for each year. It was noted that it was not possible to genetically differentiate the Firth River, Joe Creek, and Kongakut River systems from each other with the information currently available. The results indicated that for Herschel Island and Shingle Point, (locations where the majority of the harvest occurs), Dolly Varden from the Babbage River contributed between 2% (95% CI = 0–5%) and 14.4% (95% CI = 8–21%), and 30% (95% CI = 21–38%) and 89% (95% CI = 84–92%), respectively, to the harvest. It was emphasized that due to variability in fishing and sampling effort, and the timing and location of fishing activity these data may not provide an accurate representation of the coastal run.

DISCUSSION

It was suggested that future work could be done to determine if there were differences in the timing and movement of individual stocks during the sampling period (e.g., examine stock contributions on a weekly basis) as stocks might move in pulses or at different times throughout the fishing season. There was discussion on whether population sizes among stocks could account for inter-annual differences in contributions to the fishery. Someone hypothesized that the low harvest in 2013 may have resulted in the increased population abundance observed in the Babbage River that same year. Another participant replied that the hypothesis seemed unlikely given that the number of harvested fish originating from the Babbage River was low among years. There was a question about the degree to which Alaskan stocks could contribute to Canadian coastal locations. The reply was that it was difficult to compare Krueger et al. (1999) with this study because the former had used three reporting groups (two from Alaska and one from Canada) and different methodology (allozyme analysis). It was subsequently stated that the high variance around the contribution means for each group in Krueger et al. (1999) increased the degree of uncertainty in the mixed-stock analysis results. While discussing the apparent lack of genetic difference between the Firth and Kongakut river systems, a participant suggested that it could be a result of post-glacial connectivity of freshwater habitat.

PRESENTATION 7: COASTAL HARVEST

Presenter: Ellen Lea

The presentation provided an overview of how harvest information for Dolly Varden was collected and reported to various co-management bodies. Background information was presented on harvesting locations (Beaufort Sea coast, Mackenzie Delta, Firth River, and Big Fish River (mouth and 'Fish Hole')) and methods (gill netting, angling, and seining) used in recent years. The in-season communication plan for relaying harvest data to co-management partners was described. Detail was provided on specific locations where harvest and biological data were collected on an annual basis. A table summarizing the reported harvest of Dolly Varden (number of fish) among Canadian coastal locations and years (2009–2014) was presented. Coastal harvest monitoring programs were considered successful and the reported

harvest data very accurate given the high degree of support by co-management partners and harvesters.

DISCUSSION

There was discussion regarding the merits of combining or separating harvest data from Shingle Point and Sabine/King points as this had implications for genetic mixed-stock fishery analysis and estimates of the number of fish harvested from individual stocks. It was suggested that this decision should rest with both char working groups. Several participants agreed that it should be clarified that the fishery at Shingle Point primarily targets cisco (locally described as 'herring') rather than Dolly Varden. One participant mentioned that it would be useful to include a description of the past attempt to establish a commercial fishery as background information.

DEVELOPMENT OF SCIENCE ADVISORY REPORT (SAR)

The science advisory report was developed collaboratively by all participants during the meeting.

NEXT STEPS

Research documents proposed as outputs of the peer-review were confirmed by the chair of the meeting. It is noted that information on genetic population structure was published in Harris et al. (2015). The chair thanked all participants for their input into the discussions and adjourned the peer review.

REFERENCES CITED

Harris, L.N., Bajno, R., Gallagher, C.P., Koizumi, I., Johnson, L.K., Howland, K.L., Taylor, E.B., and Reist, J.D. 2015. Life-history characteristics and landscape attributes as drivers of genetic variation, gene flow, and fine-scale population structure in northern Dolly Varden (*Salvelinus malma malma*) in Canada. Can. J. Fish. Aquat. Sci. 72: 1477–1493.

Krueger, C.C., Wilmot, R.L., and Everett, R.J. 1999. Stock origin of Dolly Varden collected from Beaufort Sea coastal sites of Arctic Alaska and Canada. Trans. Am. Fish. Soc. 128: 49–57.

APPENDIX 1: TERMS OF REFERENCE

ASSESSMENT OF DOLLY VARDEN, *SALVELINUS MALMA MALMA*, FROM THE BABBAGE RIVER, YUKON TERRITORY

Regional Peer Review – Central and Arctic Region

February 9–10, 2015
Winnipeg, Manitoba

Chairperson: Margaret Treble

Context

The Babbage River is located within the Inuvialuit Settlement Region (ISR) and Dolly Varden from this system are fished by Inuvialuit beneficiaries during the summer along the Beaufort Sea coast. All Dolly Varden fisheries in the ISR are co-managed under an Integrated Fisheries Management Plan (IFMP) whose signatories are Fisheries and Oceans Canada (DFO), Fisheries Joint Management Committee, Gwich'in Renewable Resources Board, and Parks Canada Agency. The West Side Working Group, the co-management body that makes recommendations for voluntary harvest levels for Dolly Varden stocks in the ISR, has supported research activities that facilitate implementation of the IFMP, including studies to monitor harvest levels and assess the populations.

Dolly Varden from the Babbage River were last assessed in 2002. Fisheries Management has requested an updated assessment and evaluation of population status for the Babbage River stock.

Objectives

Fisheries Management requests Science advice on stock status, population abundance estimates and sustainable harvest levels for the Babbage River stock based on the following:

1. Comparison of current and past population estimates based on mark recapture methods;
2. Evaluation of count and length information of Dolly Varden obtained using a DIDSON camera;
3. Estimates of effective population size (using genetic methods) and how it relates to the mark-recapture estimates of population size;
4. Comparison of current biological information (length, sex, maturity, and growth) (2010-2014) with past data (1987) through seining conducted at the spawning/ overwintering area;
5. Evaluation of the contribution of Dolly Varden from the Babbage River to the mixed-stock-fishery at Shingle Point, Herschel Island, and Ptarmigan Bay using genetic mixed stock fishery analysis (2011-2014);
6. Compilation of annual harvest information for Dolly Varden captured along the Beaufort Sea coast (2009-2014); and
7. Estimation of current harvest rates and the associated risks for the stocks.

In addition, biological data from the Firth River system will be reviewed to establish an index for this stock.

Expected Publications

- Science Advisory Report
- Proceedings

- Research Document(s)

Participation

- Fisheries and Oceans Canada (DFO) (Ecosystems and Oceans Science, and Ecosystems and Fisheries Management sectors)
- Fisheries Joint Management Committee
- Aklavik Hunters and Trappers Committee
- Academics
- Other invited experts

APPENDIX 2: LIST OF PARTICIPANTS

Dennis Arey, Harvester (Aklavik), Inuvialuit fisheries expert

Burton Ayles, Fisheries Joint Management Committee, science expert

Rob Bajno, chemist, DFO (Winnipeg), science expert

Heather Clark, technician, DFO (Winnipeg), meeting rapporteur

Brian Dempson, Research Scientist, DFO (Newfoundland), science expert

Margaret Docker, Professor, University of Manitoba

Jay Frandsen, Parks Canada (Inuvik) [teleconference]

Colin Gallagher, biologist, DFO (Winnipeg), science expert

Danny C. Gordon, Harvester (Aklavik), Inuvialuit fisheries expert

Les Harris, biologist, DFO (Winnipeg), science expert

Kimberly Howland, Research Scientist, DFO (Winnipeg), science expert

Curtis Illasiak, Harvester (Aklavik), Gwich'in fisheries expert

Ellen Lea, biologist, DFO (Inuvik), science/fisheries expert

Tracey Loewen, graduate student, University of Manitoba, science expert

Kris Maier, biologist, GRRB (Inuvik), science/ fisheries expert

Neil Mochnacz, biologist, DFO (Winnipeg), science expert

Jim Reist, Research Scientist, DFO (Winnipeg), science expert

Peter Sinkins, Parks Canada (Inuvik) [teleconference]

Ross Tallman, Research Scientist, DFO (Winnipeg), science expert

Doug Watkinson, biologist, DFO (Winnipeg), science expert

Abe Wilson, Harvester (Fort McPherson), fisheries expert

Brett van Poorten, researcher, Conservation Science Section, British Columbia Ministry of Environment (Vancouver), modelling/ science expert [teleconference]

Xinhua Zhu, Research Scientist, DFO (Winnipeg), science expert

APPENDIX 3: MEETING AGENDA

Regional Advisory Process

Assessment of Dolly V[illegible]en, *Salvelinus malma malma*, from the Babbage River, Yukon Territory

February 9, 2015

Fisheries and Oceans Canada
Freshwater Institute (large seminar room)
501 University Crescent,
Winnipeg, Manitoba

Ph. 204-983-5000

Chair: Margaret Treble

Monday February 9

Time	Topic	Presenter
9:00-9:15	Introductory remarks Introduction of participants Review of Terms of Reference (Babbage R.)	M. Treble
9:15-9:45	Dolly Varden from the Babbage River: background	C. Gallagher
9:45-10:30	DIDSON	C. Gallagher
10:30-10:45	Break	
10:45-11:15	Mark-recapture population estimate	C. Gallagher
11:15-12:00	Population demographics (fall seining)	C. Gallagher
12:00-13:15	Lunch	
13:15-14:00	Population demographics (fall seining)	C. Gallagher
14:00-14:15	Genetic population structure and effective population size	L. Harris
14:15-14:45	Genetic mixed-stock analysis of coastal fishery	R. Bajno
14:45-15:00	Break	
15:00-15:30	Coastal harvest	E. Lea
15:30-17:00	Develop conclusions/ advice for the Science Advisory Report	M. Treble